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Guest editorial: special issue on wide area monitoring, protection and control in smart grid

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Complexity of modern electrical power systems is steadily increasing. This is inspiring researchers and developers to propose new solutions capable to address a number of challenges, particularly those related to power system operation. A massive penetration of asynchronously connected renewable energy generation, the generation connected over inverters, is significantly changing the dynamics of modern power systems. From one hand, the power system response time is becoming shorter and at the same time the fault level is becoming smaller. This is significantly affecting requirements of control loops, as well as power system protection. Utilization of modern sensor and communication technology looks to be the critical technological enabler for addressing the mentioned challenges. In this context, development of Wide Area Monitoring, Protection and Control (WAMPAC) systems, based on Synchronized Measurement Technology represented by Phasor Measurement Units (PMUs), looks to be a part of the solution. This MPCE Special Issue is focused on those solutions, which will contribute to a more reliable, economical and secure operation of future smart grids. They are addressed in eighteen manuscripts, briefly discussed below.

1) We were privileged to have Prof A Phadke, who wrote a paper on improving the performance of power system protection using Wide Area Monitoring Systems. As it is known, Prof Phadke is considered to be the inventor of PMUs. This paper is discussing new opportunities for improving principles of power system protection using PMUs.
2) Y Liu provided his contribution related to power system restoration. It is expected that power system restoration will be significantly improved by using PMUs, so that this paper gives an excellent overview of the existing restoration strategies.
3) PMUs are connected in substations and the quality of measured voltages and currents is determining the quality of PMU outputs (frequency, synchrophasors…). From this perspective, papers written by F Li and T Bi discuss the impact of data quality and superimposed harmonics, on the functionality of PMUs.
4) As it is known, the implementation of estimation theory in power systems is very broad. However, the estimation of power system state is considered as one of the most critical stages in operation of modern Energy Management Systems. H Chen is providing a contribution on this topic. State estimation can be significantly improved by using PMUs, what can result in an advanced situational awareness and decision making. Furthermore, parameter estimation techniques can be used for estimation of model parameters of wind farms (see paper written by C Lu).
5) T Jang and C Shen addressed issues related to power system oscillations. These can cause fatal consequences to power systems, also blackouts. A typical example is sub-synchronous resonance. Monitoring of such oscillations is not trivial and it is expected that PMUs will help in monitoring such oscillations.
6) From the perspective of utilization of Synchronized Measurement Technology, applications for Wide Area Monitoring are considered not to be a big challenge.

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On contrary, development of Wide Area Control applications has quite a different dimension of complexity. Papers written by Y Liu and N E Wu are providing contributions on this topic.

7) Applications in the field of Wide Area Protection can be considered as the most challenging and demanding. We are pleased to show several papers (authors F Wen, J Jia and F Wei), which are proposing solutions which are expected to help in eliminating cascading events and catastrophic power system blackouts. Approaches based on intentional splitting of power systems, as well as on substation area joint defensive protection strategies, are considered as serious candidates for those approaches which will significantly contribute to the secure operation of future smart grids. Important contribution on identifying fault area in a power system is given by C-H Kim. Here an interesting approach based on PMUs and travelling waves principle is presented.
8) Advancements in the field of substation automation and communication technology are demonstrated in papers written by S Muhammad and G Liang. WAMPAC systems rely on the efficacy of primary and secondary plant in substations at all voltage levels. Utilization of modern communication protocols like IEC-61850 is contributing to the quality of communication between different intelligent electronic devices. On the other hand, the aspects of cyber security are still being explored and as such determine future development of WAMPAC systems.
9) Last but not least, P Wall provided his contribution on deployment and demonstration of a Wide Area Monitoring System in the power system of Great Britain. Both China and Great Britain are countries in which the importance of development of WAMPAC systems has been already recognized, so that Wall's paper is providing a contribution addressing developments in the GB power system.

We believe that this Special Issue will motivate new research on the topics related to WAMPAC and by this contribute to the prosperity of modern societies, which as such definitely relies on the reliability and security of electrical power systems, which are considered to be one of the most important critical infrastructures created by mankind ever.

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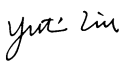

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